MACROINVERTEBRATE ASSESSMENT OF PENNYROYAL AND TURKEY CREEKS NEAR THE WINYAH ELECTRIC GENERATING STATION GEORGETOWN COUNTY, SOUTH CAROLINA

Report To

SOUTH CAROLINA PUBLIC SERVICE AUTHORITY

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AQUATIC ANALYSTS
Aquatic Biologists & Toxicologists

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I. SUMMARY

A macroinvertebrate assessment was made by AQUATIC ANALYSTS, May 22, 1984, on Pennyroyal and Turkey Creeks near the Winyah Electric Generating Station, to determine any impact of the station's 008 and 002 discharges.

1. A total of 273 organisms representing 11 taxa were collected from Pennyroyal Creek. The macroinvertebrate community was dominated numerically by the amphipod Gammarus fasciatus with a total of 228 specimens captured from the creek.

2.Collection data from the Pennyroyal Creek assessment yielded low diversity values.

3. Significant fluctuations in number of taxa, number of organisms and diversity values have been observed from each sampling station since 1980. Natural environmental stresses (e.g., tidal changes in water level and salinity as well as lack of variation in substrate type) associated with the upper reaches of an estuary are probably responsible for the poor diversity found in Pennyroyal Creek.

4. A total of 522 organisms representing 29 taxa were collected from Turkey Creek. The predominant groups included caddisflies and non-biting midges.

5. It does not appear that the Winyah Station cooling pond discharge is having an adverse impact on the macroinvertebrate community of Turkey Creek.

II. INTRODUCTION

On May 22, 1984, a macroinvertebrate assessment was made on Pennyroyal and Turkey Creeks near the South Carolina Public Service Authority's Winyah Generating Station, Georgetown County, South Carolina. The objective of this assessment was to determine what impact, if any, the Winyah Station discharges 008 and 002 had on the aquatic and semi-aquatic macroinvertebrate community of Pennyroyal and Turkey Creeks. This was the fourth assessment of these two creeks since 1980.

III. DESCRIPTION OF STUDY AREAS

Qualitative collections of aquatic and semi-aquatic macroinvertebrates were made from three sampling stations in each Pennyroyal and Turkey Creeks (Figure 1). The location of each station was the same as those used during the previous studies (Enwright Laboratories, 1982).

Station 1 in Pennyroyal Creek was located approximately 0.6 km upstream from discharge 008. This station served as the control for the Pennyroyal Creek assessment. The second station was established at discharge 008, approximately 0.4 km upstream from the S.C. Secondary Road 42 (Pennyroyal Road) bridge crossing. Station 3 was established approximately 1.2 km downstream from the bridge. Pennyroyal Creek was approximately 12 m wide and about 2.5 m deep at Stations 1 and 2 and expanding to about 3.5 m deep and 25 m wide at Station 3. Pennyroyal Creek at Stations 1 and 2 was surrounded by

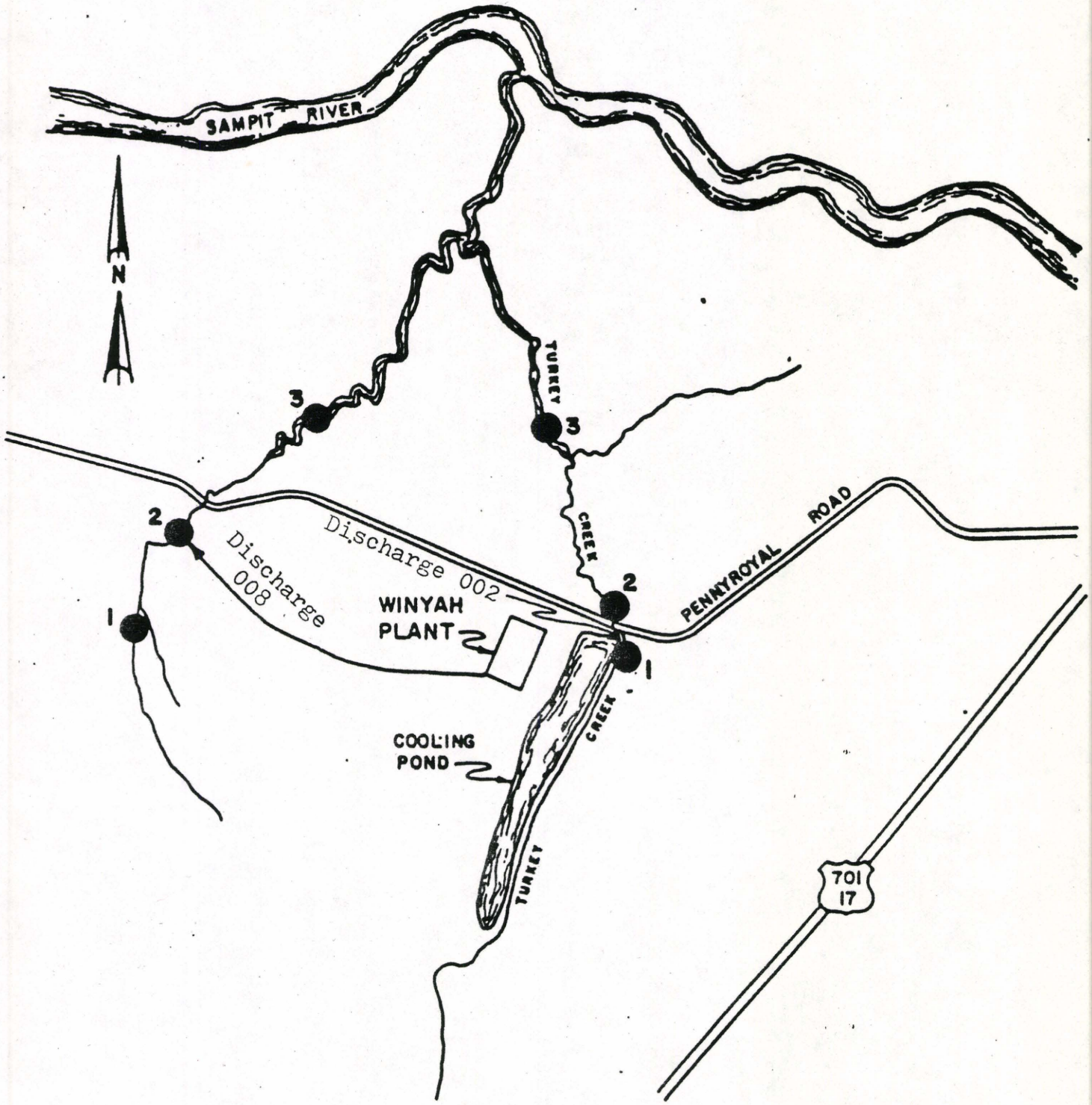

FIGURE 1

MACROINVERTEBRATE SAMPLING STATIONS IN PENNYROYAL CREEK AND TURKEY CREEK

Map adapted from Enwright (1982)

bald cypress, water tupelo, pickerel weed, arrowheads and other plants characteristic of the tidal freshwater marshes of South Carolina. Steep mud banks, dense root systems and submerged logs were exposed in the creek at low tide. The creek at Station 3 was bordered by cordgrass marsh, charactistic of estuarine wetlands. Pennyroyal Creek near discharge 008 is part of the transition zone between freshwater and brackish tidal marshes. Changes in salinity and water level occur with each tidal fluctuation. The substrate at all stations was predominately silt and fine sands with small amounts of plant debris.

Discharge 002 enters Turkey Creek approximately 0.1 km upstream of the Pennyroyal Road bridge crossing. Station 1 in Turkey Creek was located approximately 0.2 km upstream from the discharge point in the channelized portion of the creek. This station served as the control for the Turkey Creek assessment. Station 2 was established at the Pennyroyal Road bridge crossing. Station 3 was located approximately 2.8 km downstream from the bridge and approximately 2.0 km upstream from the confluence of Turkey Creek and Pennyroyal Creek. Turkey Creek at Station 1 ranged from approximately 1.0 to 7.0 m wide and 0.1 to 1.0 m deep. This portion of the creek was not tidally influenced. Cattails, bullrushes, pickerel weed and alligator weed were common along the banks and throughout the creek. Submerged filamentous green algae was also found at Station 1. The creek flow at this station was swift. Turkey Creek at Station 2 formed a small pool with an average width of 6 m and ranged in depth from 1.0 to 1.8

m. Much of Station 2 was shaded by overhanging pine trees and the surrounding banks were moderately populated with pickerel weed. The substrate at Stations 1 and 2 was composed of plant debris and fine sand. Turkey Creek at Station 3 was tidally influenced and had a similar width and depth as Pennyroyal Creek at Station 3. Some bald cypress bordered the creek but the area was dominated by cordgrass.

IV. METHODS

Qualitative collections were conducted by Richard Shealy with assistance from Rob Javins, of AQUATIC ANALYSTS, and Jimmy Carter and Sam Taylor, of SANTEE COOPER. Collections were made with a flat-bottom aquatic dip net, a U.S. Standard No. 30 sieve and by hand using forceps for picking organisms from hard substrates. All available habitats (e.g., stream margins, leaf packets and debris, water-soaked logs and sand deposits) were sampled. Samples were preserved in the field with 10% Formalin. Each sample represented about 20 minutes of sampling effort. The macroinvertebrate collections in Pennyroyal Creek were made on an ebb tide shortly before slack low tide. Station 3 in Turkey Creek was sampled on a flood tide approximately midway through the tidal cycle. Sampling procedures were similar at each station to enable species and numerical population comparisons among stations.

Dissolved oxygen, pH, water temperature and conductivity were determined at each station in conjunction with the sampling effort.

Upon return to the laboratory, each sample was placed in a U.S. Standard No. 30 sieve and rinsed to remove mud and small sand

particles. Macroinvertebrates were sorted from debris with the aid of an illuminated magnifier and then transferred to 70% ethanol. They were identified to the lowest positive taxonomic level and counted with the aid of appropriate microscopic techniques and taxonomic keys. All organisms will be kept in AQUATIC ANALYSTS' macroinvertebrate collection for two years.

Species diversity indices were computed for the data. Species diversity is a function of the number of species in a given area and of the evenness with which the individuals are distributed among the species (Smith, 1974). The index is used to estimate diversity of the macroinvertebrate community upstream and downstream of the discharge. In general, unstressed communities contain a few individuals of many species and diversity is relatively high. Species diversity may attain values of three or four in these communities. Diversity is lowered by many forms of stress (e.g., temperature, salinity and water level changes as well as comtamination from organic and inorganic pollutants).

V. RESULTS AND DISCUSSION

A. Pennyroyal Creek

A total of 273 organisms representing 11 taxa were collected from Pennyroyal Creek. A species list with numbers of specimens collected is given in Table 1. Low numbers of taxa were collected during this assessment. The macroinvertebrate community was dominated numerically by a single species of amphipod, Gammarus fasciatus, with

Table 1. Macroinvertebrates collected from Pennyroyal Creek near Winyah Electric Generating Station, Georgetown County, South Carolina, May 22, 1984.

Taxon	Stations 1	2	3
A=Adult(s) L=Larva(e) N=Naiad(s) or Nymph(s) P=Pupa(e)			
Annelida			
Oligochaeta (Aquatic Worms)			
Tubificidae	14	3	6
Arthropoda			
Crustacea			
Amphipoda (Side Swimmers)			
Corophiidae			
Corophium sp.	-	-	1A
Gammaridae			
Gammarus fasciatus	32A	106A	90A
Decapoda			
Palaemonidae (Grass Shrimp)			
Palaemonetes pugio	-	-	1A
Ocypodidae (Fidder Crabs)			
Uca minax	A*	A*	A*
Insecta			
Odonata (Damselflies & Dragonflies)			
Coenagrionidae			
Argia sp.	2N	-	-
Heteroptera			
Corixidae (Water Boatmen)	2A	2A	-
Megaloptera			
Sialidae (Alderflies)			
Sialis sp.	1L	-	-
Trichoptera (Caddisflies)			
Polycentropodidae			
Polycentropus sp.	5L	-	-
Diptera			
Chaoboridae (Phantom Midges)			
Chaoborus punctipennis	-	1L	2L
Chironomidae (Non-Biting Midges)			
Procladius sp.	1L	-	2L,1P
Crytochironomus sp.	-	-	1L

Table 1. Continued.

	Stations 1	2	3
TOTAL TAXA	8	5	8
TOTAL ORGANISMS	57	112	104
SPECIES DIVERSITY INDEX	1.82**	0.38	0.87

* Adults observed in abundance on creek banks but not quantified.

** Diversity index has reduced reliability because of the relatively small number of organisms collected.

a total of 228 specimens captured from the creek. Fiddler crabs were present at each station but not quantified because collection methods were not conducive to capturing these highly mobile animals.

Station 1 yielded 57 specimens representing 8 taxa. Gammarus faciatus was the most abundant species with 32 individuals collected. Aquatic worms represented 25% of the collection from this station. Damselflies, water boatmen, an alderfly, caddisflies and a non-biting midge were also captured from Station 1. A species diversity index of 1.82 was calculated for these data.

The macroinvertebrate community at Station 2, directly downstream of discharge 008, was composed almost entirely of G. fasciatus. A total of 106 (95% of the composition of Station 2) amphipods were collected from this station. Aquatic worms, water boatmen and a phantom midge were collected. These data yielded a species diversity index of 0.38.

The sampling effort at Station 3, approximately 1.2 km downstream from discharge 008, produced 104 specimens representing 8 taxa. G. fasciatus, with 90 specimens captured from this station, continued to numerically dominate the community of Pennyroyal Creek. Aquatic worms, a corophiid amphipod, a grass shrimp, phantom midges and non-biting midges were also collected. A diversity index of 0.87 was calculated for these data.

COMPARISONS OF 1980, 1981, 1982 AND 1984 DATA

A summary of macroinvertebrate data collected from Pennyroyal Creek during 1980, 1981, 1982 and 1984 is presented in Table 2. Total number of taxa and organisms at Stations 1 and 2 fell from 1982 while both increased at Station 3. The 1984 Station 1 diversity index was significantly higher than the May 1982 index. Total organisms collected from Stations 1 and 2 during 1984 was lower than 1982 but comparable to the 1981 figures. Aquatic worms overwhelmingly dominated species composition of the May 1982 collections (Enwright Laboratories, 1982). Relatively small numbers of aquatic worms were encountered during this study.

As in previous assessments, species diversity index values for the Pennyroyal Creek stations were low (Table 1). During this assessment, poor diversity values were caused by the domination of G. fasciatus and the low number of other taxa collected from the creek. The transition zone between the freshwater and marine aquatic environments is typically populated by high density and low numbers of taxa (Allen, et. al., 1982). Tidal fluctuations in water level and salinity as well as lack of variation in substrate, characteristic of tidal creeks (Gosner, 1971), are a few of the natural environmental stresses confronting organisms inhabiting the upper reaches of an estuary. Few species have adapted to such stressful conditions. The dramatic variations in the taxa, abundance and diversity that have characterized the macroinvertebrate community

Table 2. Summary of macroinvertebrate data collected qualitatively from Pennyroyal Creek near the Winyah Electric Generating Station, Georgetown County, South Carolina.

Station	Date	Total Taxa	Diversity Index	Total Organisms
Sta. 1	May 1980	12	1.45	426
	May 1981	8	1.73*	50
	May 1982	9	0.74	198
	May 1984	8	1.82*	57
Sta. 2	May 1980	12	1.28	263
	May 1981	9	2.32	95
	May 1982	6	0.29	312
	May 1984	5	0.38	112
Sta. 3	May 1980	10	1.95*	69
	May 1981	4	0.46*	73
	May 1982	6	1.06	90
	May 1984	8	0.87	104

* Diversity index has reduced reliability because of the relatively small sample size.

of Pennyroyal Creek since the assessments began in 1980, were probably caused by natural stresses affecting organisms in tidal creeks.

B. Turkey Creek

A total of 522 organisms representing 29 taxa were collected from Turkey Creek May 22, 1984. A species list with numbers of specimens collected is given in Table 3.

Station 1, the control for the Turkey Creek assessment, yielded 234 organisms representing 15 taxa with a diversity index of 2.12. A single caddisfly species, Hydropsyche simulans, made up a total of 128 of the 234 specimens collected from this station. The amphipod, Cangonyx sp., was another major contributor (56 specimens) to the species composition of Station 1. Other organisms collected from this sampling station were aquatic worms, fingernail clams, a damselfly, an alderfly, polycentropodid caddisflies,a diving beetle, riffle beetles, black fly pupae, biting midges, non-biting midges and a lepidopteran larva.

Station 2,downstream of discharge 002, yielded 17 taxa and 274 specimens. The community was dominated numerically by the midge Endochironomus nigricans, which represented 66% of the total composition of this station. The abundance of E. nigricans was probably due to accumulations of plant detritus in the broad section of the creek at the Pennyroyal Road bridge. Aquatic worms, a leech,

Table 3. Macroinvertebrates collected from Turkey Creek near Winyah Electric Generating Station, Georgetown County, South Carolina, May 22, 1984.

Taxon	Stations 1	2	3
A=Adult(s) L=Larva(e) N=Naiad(s) or Nymph(s) P=Pupa(e)			
Annelida			
Oligochaeta (Aquatic Worms)			
Branchiobdellia	-	1	-
Tubificidae	9	18	-
Polychaeta (Bristle Worms)			
Nereidae			
Nereis sp.	-	-	1
Ampharetidae			
Amphicteis gunneri	-	-	1
Hirudinea (Leeches)			
Glossiphoniidae			
Helobdella sp.	-	1	2
Mollusca			
Pelecypoda			
Sphaeriidae (Fingernail Clams)			
Sphaerium sp.	13	19	-
Arthropoda			
Crustacea			
Amphipoda (Side Swimmers)			
Corophiidae			
Corophium sp.	-	-	5A
Gammaridae			
Crangonyx sp.	56A	7A	-
Isopoda (Pill Bugs)			
Anthuridae			
Cyathura polita	-	-	1A
Decapoda			
Cambaridae (Crayfish)			
Procambarus troglodytes	-	1A	-
Palaemonidae (Grass Shrimp)			
Palaemonetes pugio	-	-	3A
Ocypodidae (Fidder Crabs)			
Uca minax	-	A*	A*
Insecta			
Ephemeroptera (Mayflies)			
Ephemeridae			
Hexagenia bilineata	-	6N	-

Table 3. Continued.

Taxon	Stations 1	2	3
A=Adult(s) L=Larva(e) N=Naiad(s) or Nymph(s) P=Pupa(e)			
Odonata			
Coenagrionidae (Damselflies)			
Argia sp.	-	1N	-
Enallagma sp.	1N	2N	-
Gomphidae (Dragonflies)			
Gomphus sp.	-	1N	-
Megaloptera			
Sialidae (Alderflies)			
Sialis sp.	1L	1L	-
Trichoptera (Caddisflies)			
Hydropsychidae			
Hydropsyche simulans	128L	-	-
Polycentropodidae			
Polycentropus sp.	5L	9L	-
Coleoptera			
Dytisidae (Diving Beetles)			
Dytiscus sp.	1L	-	-
Elmidae (Riffle Beetles)			
Dubiraphia sp.	-	1L	-
Stenelmis sp.	4L	-	-
Diptera			
Simuliidae (Black Flies)			
Simulium sp.	2P	-	-
Ceratopogonidae (Biting Midges)			
Bezzia sp.	2L	-	-
Chironomidae (Non-Biting Midges)			
Procladius sp.	3L	24L	-
Crytochironomus sp.	-	-	1L
Endochironomus nigricans	1L	180L,1P	-
Polypedilum sp.	7L	-	-
Lepidoptera			
Pyralidae (Butterflies and Moths)			
Parapoynx sp.	1L	1L	-
TOTAL TAXA	15	17	8
TOTAL ORGANISMS	234	275	14
DIVERSITY INDEX	2.12	1.93	2.50**

* Adults observed in abundance on creek banks but not quantified.
** Diversity index has reduced reliability because of the relatively small sample size.

fingernail clams, amphipods, a crayfish (along with a parasitic branchiobdellid worm), mayflies, damselflies, a dragonfly, an alderfly, caddisflies, non-biting midges (Procladius sp.) and a lepidopteran larva were also collected from Station 2. Collection data yielded a diversity index of 1.93.

Station 3, approximately 2.8 km downstream from the Pennyroyal Road bridge, yielded 14 specimens representing 8 taxa. Estuarine species composed most of the sample from Station 3. Bristle worms, corophiid amphipods, anthurid isopods, grass shrimp and fiddler crabs are found in abundance in South Carolina's estuaries. The data from this station yielded a species diversity of 2.50.

COMPARISONS OF 1980, 1981, 1982 AND 1984 DATA

A summary of macroinvertebrate data collected during 1980, 1981, 1982 and 1984 is given in Table 4. The number of taxa fell by one at both Station 1 and Station 3 while Station 2 increased by three taxa over the 1982 collections. The total number of organisms at Station 1 and 2 changed by less than 10% during the same period. A dramatic decrease in the number of organisms was observed at Station 3 over the last two years. In that there was not a similar reduction in the number of organisms but rather an increase in the number of taxa and organisms from Station 2 indicates that discharge 002 is not impacting the macroinvertebrate community of Turkey Creek. The reduction in the number of organisms from Station 3 may have been

Table 4. Summary of macroinvertebrate data collected qualitatively from Turkey Creek near the Winyah Electric Generating Station, Georgetown County, South Carolina.

Station	Date	Total Taxa	Diversity Index	Total Organisms
Sta. 1	May 1980	22	NQ*	NQ
	May 1981	11	2.39	211
	May 1982	16	2.51	253
	May 1984	15	2.12	234
Sta. 2	May 1980	21	2.76	200
	May 1981	11	3.16**	41
	May 1982	14	2.71	247
	May 1984	17	1.93	274
Sta. 3	May 1980	12	1.29	395
	May 1981	6	1.24	167
	May 1982	9	1.81	164
	May 1984	8	2.50**	14

* Not quantified; too numerous to count.

** Diversity index has reduced reliability because of the relatively small sample size.

caused by (1) effluent from a sewage treatment plant discharged into Turkey Creek upstream from Station 3, (2) changes in salinity resulting from fluctuations in rainfall or (3) other naturally induced environmental stressess. Diversity index values for Stations 1 and 2 declined while the diversity at Station 3 increased to the highest value (2.50) since the assessments of Turkey Creek began in 1980.

The data collected from this assessment indicate that Turkey Creek supports a relatively unbalanced macroinvertebrate community upstream and downstream of the cooling pond discharge point. Based on these findings it does not appear that the Winyah Station cooling pond discharge is having an adverse impact on the aquatic and semi-aquatic macroinvertebrate community of Turkey Creek.

Water quality data recorded during the assessments are given in Table 5.

Table 5. Water quality parameters measured in conjunction with the macroinvertebrate sampling from Pennyroyal and Turkey Creeks near the Winyah Electric Generating Station, Georgetown County, South Carolina, May 22, 1984.

Parameter	Pennyroyal Creek Stations			Turkey Creek Stations		
	1	2	3	1	2	3
Dissolved Oxygen (mg/l)	7.6	7.2	7.2	7.3	6.9	8.1
pH (SI)	6.3	6.6	6.5	6.2	5.8*	6.2
Water Temperature (°C)	25.5	24.0	27.0	29.0	27.0	25.5
Conductivity (µmhos/cm)	805	1150	1190	185	175	570

* The low pH recorded from Turkey Creek at Station 2 appears to be a natural phenomenon. The pH of the cooling pond near the discharge point was recorded at 7.5 shortly after the Turkey Creek measurement was made.

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